The hidden seismic symphony in earthquake signals

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by Paul Johnson

Few months go by without another devastating earthquake somewhere in the world reminding us how we all remain at the mercy of major seismic events that strike without warning. But a new branch of geophysics powered by machine learning is uncovering fresh insights into the earth's slipping faults that often trigger these catastrophic earthquakes.

Machine learning, which often goes by the catchier moniker of artificial intelligence, has captured the public's imagination with its promises of fully autonomous cars and the approaching "singularity" when machines out-think people. The current state of the art, however, shows little signs of true intelligence, such as the ability to abstract the principles behind a given phenomenon. In image recognition, AI systems learn from rote memorization to identify objects and are, therefore, often fooled. For these reasons, machine learning remains a more appropriate term for this branch of computational science.

Many of the recent headline-grabbing developments in machine learning hinge on an approach called deep neural networks. Yet a simpler and more transparent form of machine learning called decision trees is unlocking impressive new scientific discoveries. In the case of our earthquake research at Los Alamos National Laboratory, a machine-learning process involving decision trees has revealed previously unsuspected physics principles that a deep neural network would have obscured and humans poring over data sets probably never would have noticed. To our surprise —and delight—this approach has led to a breakthrough in probing the mechanics of earthquakes, which will certainly advance our pursuit of the holy grail of geoscience: earthquake forecasting.

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